NASA TECHNICAL MEMORANDUM

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COMPENDIUM OF METEOROLOGICAL DATA FOR THE CENTAUR LAUNCH IN FEBRUARY 1974

By J. Briscoe Stephens, S. I. Adelfang, and A. I. Goldford
Space Sciences Laboratory

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16. ABSTRACT

The meteorological data for the 33-hour period prior to the Centaur (Titan III E) launch from Kennedy Space Center at 0948 EDT on February 11, 1974, are archived in this report. These data were collected in support of the NASA rocket exhaust effluent prediction and monitoring program. This is a rather unique data set in that a high temporal resolution of upper air soundings is provided. All supporting data, such as synoptic charts and wind tower data, are also included. This is the second in a series of seven data reports.

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TECHNICAL MEMORANDUM X-73335

COMPENDIUM OF METEOROLOGICAL DATA FOR THE CENTAUR LAUNCH IN FEBRUARY 1974

I. INTRODUCTION

This report is a compendium of all the meteorological data collected as a function of the joint Marshall Space Flight Center (MSFC)/Langley Research Center (LaRC)/Kennedy Space Center (KSC) rocket exhaust effluent prediction and monitoring program for the Centaur, a Titan III E launch from Kennedy Space Center at 0948 EDT on February 11, 1974. The data presented in this compendium were collected largely to support NASA/MSFC diffusion predictions for the deployment of NASA/LaRC monitoring sites. The joint solid rocket motor exhaust prediction (MSFC) and measurement (LaRC and KSC) program evolved in 1972 utilizing the Titan and Delta launches as a source for empirical information that can be employed to more accurately predict the environmental effects of planned Space Shuttle operations.

These data are archived both as an aid in postlaunch analysis and because they represent a unique set of atmospheric soundings with high temporal resolution. Included in the report are the synoptic charts, surface observations, rawinsonde and windsonde soundings, and satellite cloud imagery obtained during this period. There is no attempt to analyze any of the data presented in this document but rather to provide a data source for future analysis.

II. DATA

The data are listed in Appendices A through E; page numbers for specific data are given in the Table of Contents. The dates, times, and sources of the data are listed in Table 1.

The synoptic charts are from the series published weekly by the National Oceanographic and Atmospheric Administration (NOAA). The surface data are from the Cape Canaveral Air Force Station (location shown as KSC meteorological station in Figure 1).

The rawinsonde runs were made with an AMQ-9 radiosonde (Fig. 2) using the GMD-4 rather than the NOAA J005B radiosonde system. The temperature and humidity sensor data are transmitted ten times per minute in the AMQ-9

TABLE 1. METEOROLOGICAL DATA SUMMARY FOR THE CENTAUR LAUNCH ON 11 FEBRUARY 1974 AT 0948 EDT (1448Z)

Data Type	Date (Feb 1974)	Time		Source
		EDT	Relative[a]	
Synoptic Charts[b]	10	0800	T-25 hr 48 min	NOAA
	11	0800	T- 1 hr 8 min	NOAA
	12	0800	T+ 22 hr 12 min	NOAA
Surface Observations[c]	11, 12	0158 to 0056 (12 Feb)	T- 7 hr 50 min to T+15 hr 8 min	USAF
Rawinsonde	10	0115	T-32 hr 33 min	USAF
	10	0715	T-26 hr 33 min	USAF
	10	1030	T-23 hr 18 min	USAF
	10	2300	T-10 hr 48 min	USAF
	11	0030	T- 9 hr 18 min	USAF
	11	0600	T- 3 hr 48 min	USAF
	11	0910	T- 38 min	USAF
Windsonde	11	0503	T- 4 hr 45 min	USAF
Satellite Imagery (IR)	10	2058	T-12 hr 50 min	USAF
	11	2205	T+12 hr 17 min	USAF

[a] Relative to launch time; for example, 0950 EDT = T+2 min.

[b] Charts for surface and 500 mb; also included are precipitation and maximum and minimum temperatures for the preceding 24-hr period.

[c] Location of the base station for upper air and surface observations is illustrated in Figure.

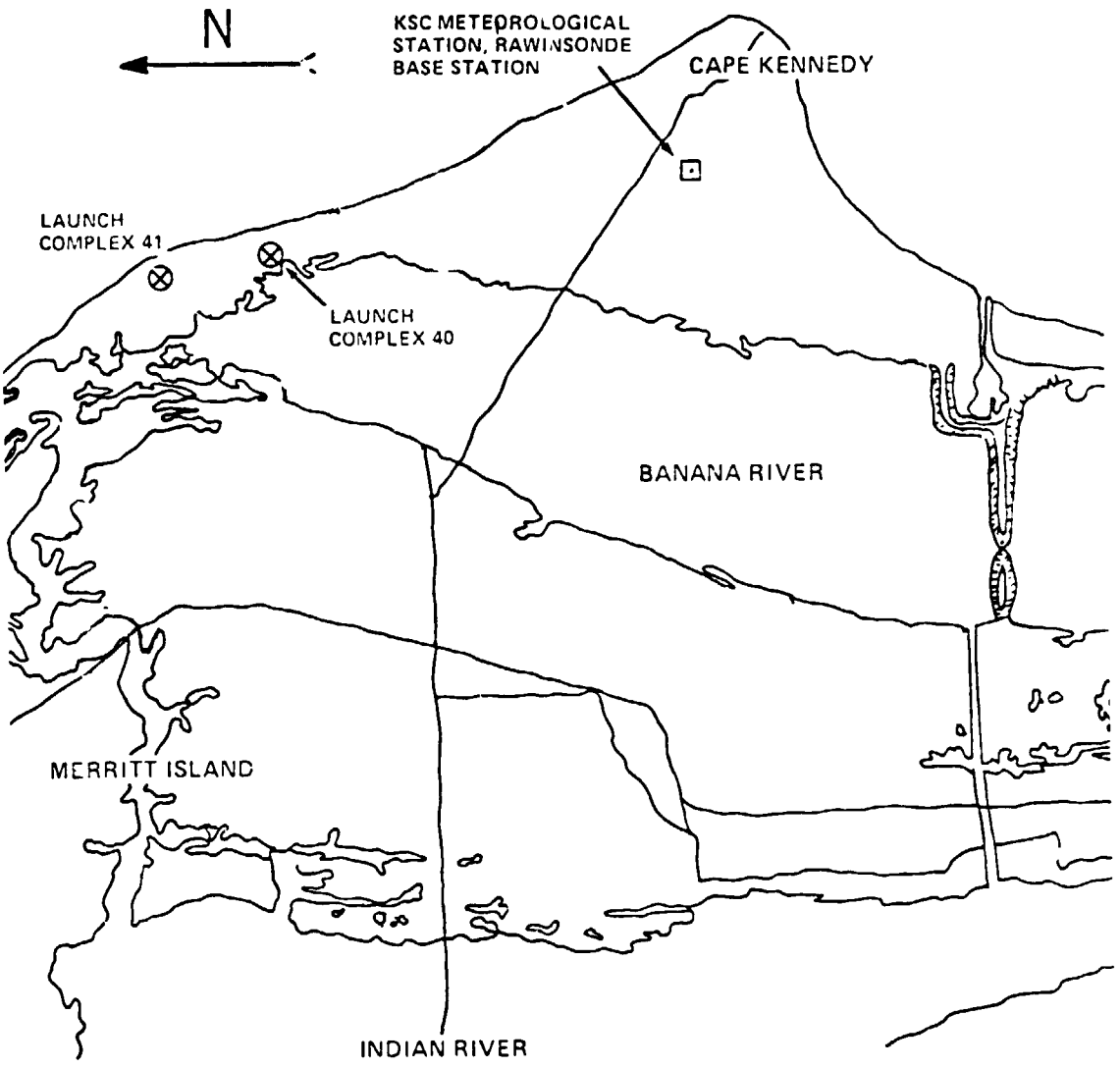

Figure 1. Location of KSC meteorological station for surface and upper-air observations.

Figure 2. AMQ-9 radiosonde.

by a clock-actuated switch rather than the aneroid barometer switch used in the NOAA radiosonde. Both systems measure azimuth and elevation with the directional receiver in the GMD. A transponder in the AMQ-9 is used to obtain the slant range to the radiosonde, enabling the calculation of altitude. The pressure is then calculated according to the hypsometric equation. The equations used in the computer program to calculate various thermodynamic quantities from the basic altitude, temperature, and relative humidity data are given in Appendix F.

The windsonde measures Eulerian[1] wind direction and speed as a function of altitude and is similar to the rawinsonde (AMQ-9) except that it does not have temperature and humidity sensors.

Since it is envisioned that use of the rawinsonde and windsonde data will be restricted to studies of the stabilized Space Shuttle rocket booster cloud, an altitude limit of 6.8 km (20 000 ft) was chosen; all data beyond that altitude are not included in this report. The excluded data are archived at MSFC and are available.

The data contained in this report cover a time period that is sufficient for most anticipated meteorological analyses. The chronology of the data relative to the time of launch is given in Figure 3. In most studies data within 1.5 hours of launch time (0948 EDT, 11 February) are sufficient. To facilitate retrieval of these data, an index is provided in Table 5 which gives the page number of data obtained within 1.5 hours of launch. It is understood that for dynamic situations, such as the onset of a sea breeze or the passage of a front within 1.5 hours of launch, the selection of data would have to be narrowed to a more appropriate period.

III. LAUNCH CONDITIONS

At launch the KSC meteorological station reported a clear sky with a visibility of 10 miles. The surface wind was from the west-northwest at 7 knots. A rawinsonde sounding taken 38 minutes before launch indicated a northwest wind at 25 knots at 1.05 km (3446 ft). The northwest wind was responsible for the observed offshore trajectory of the stabilized exhaust cloud.

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[1]For practical applications the rawinsonde and windsonde data are treated as Eulerian.

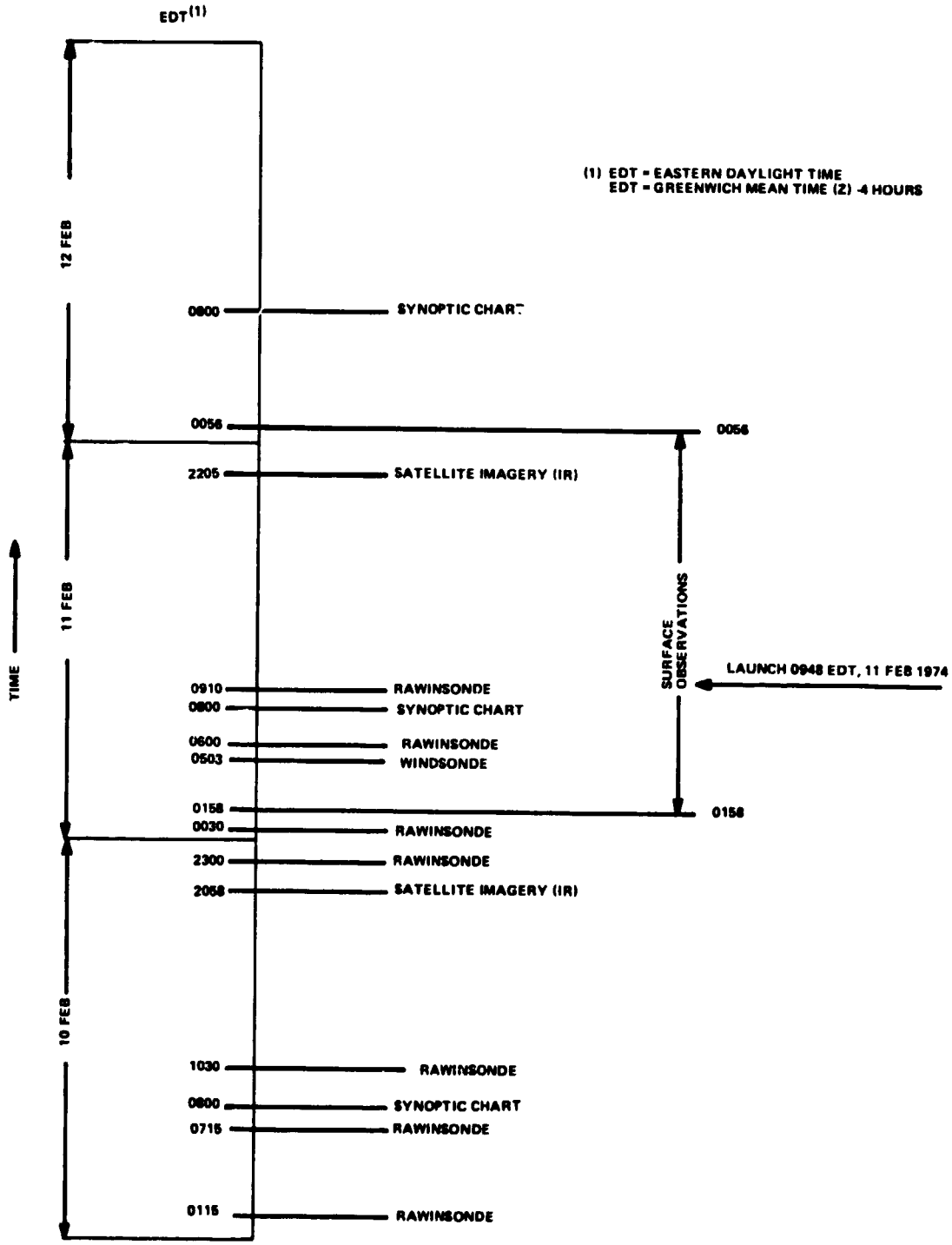


Figure 3. Data chronology.

TABLE 2. METEOROLOGICAL DATA OBTAINED WITHIN 1.5 HOURS OF T-0 (0948 EDT, 11 February 1974)

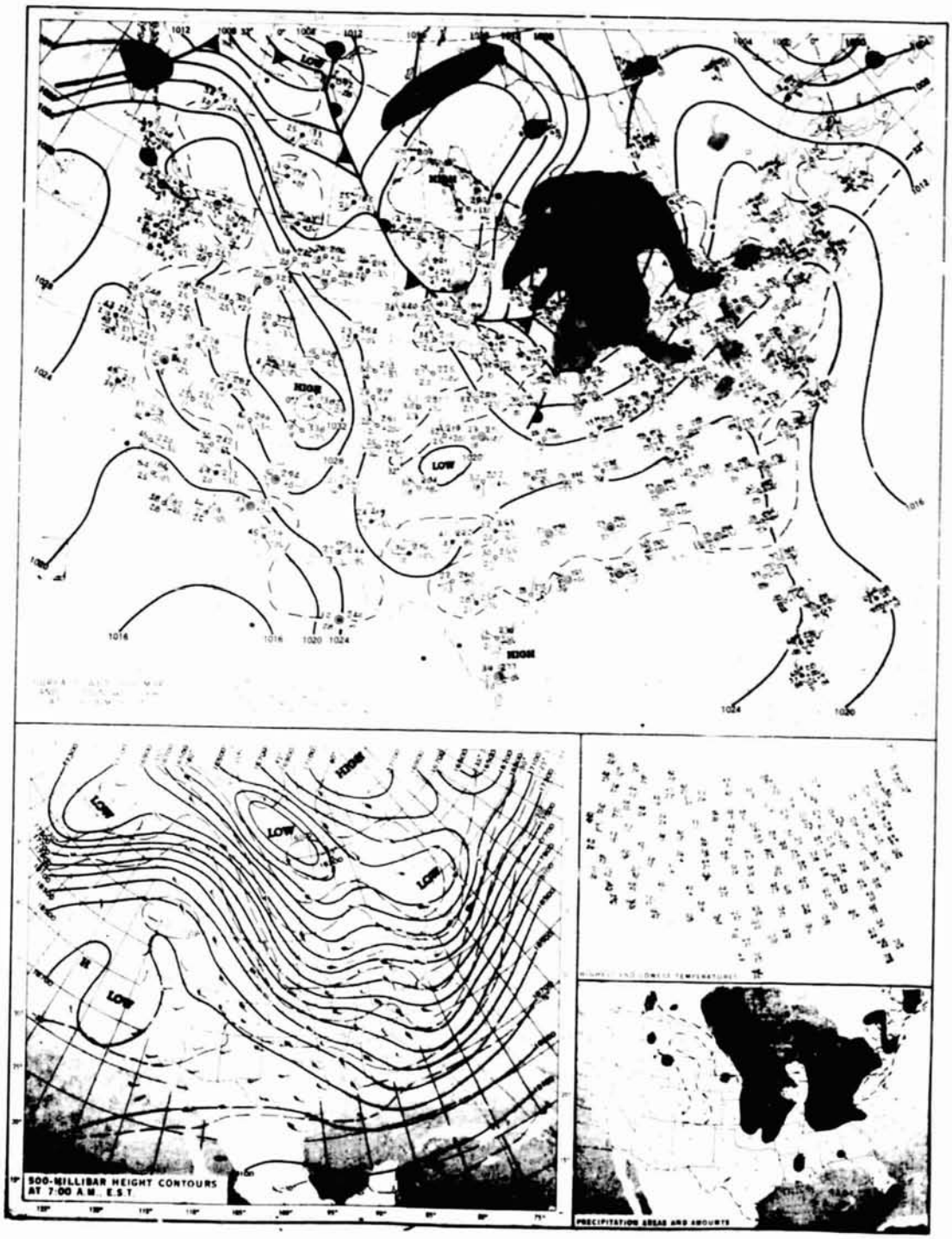
TIME	DATA TYPE	PAGE
T-68 min (0845 EDT)	Synoptic Charts	9
T-63 min (0845 EDT)	Surface Observation	14
T-50 min (0858 EDT)	Surface Observation	14
T-38 min (0910 EDT)	Rawinsonde	22
T-33 min (0915 EDT)	Surface Observation	14
T-18 min (0930 EDT)	Surface Observation	14
T- 3 min (0945 EDT)	Surface Observation	14
T+ 1 min (0949 EDT)	Surface Observation	14
T+ 2 min (0950 EDT)	Surface Observation	14
T+ 10 min (0958 EDT)	Surface Observation	14
T+68 min (1056 EDT)	Surface Observation	14

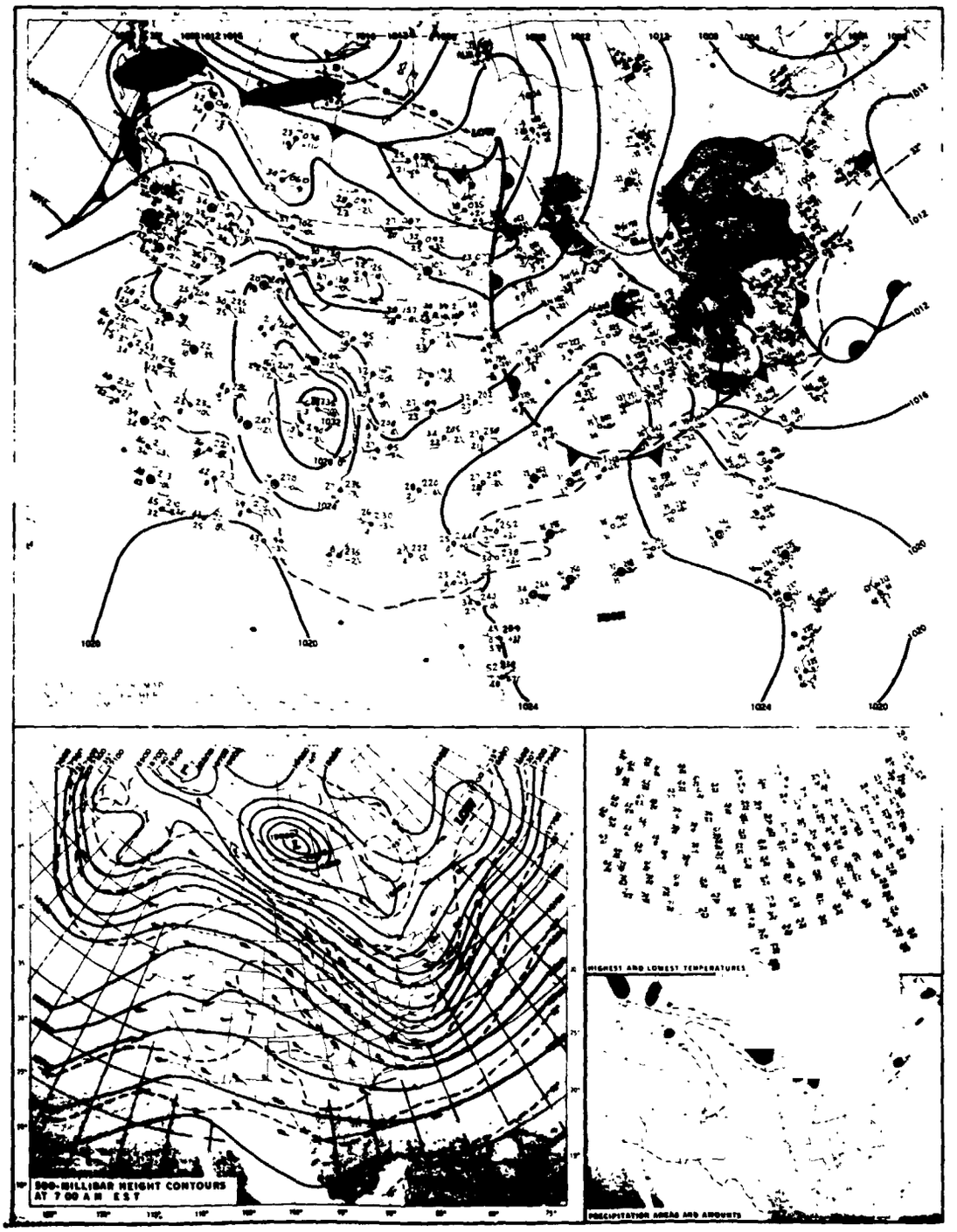
APPENDIX A

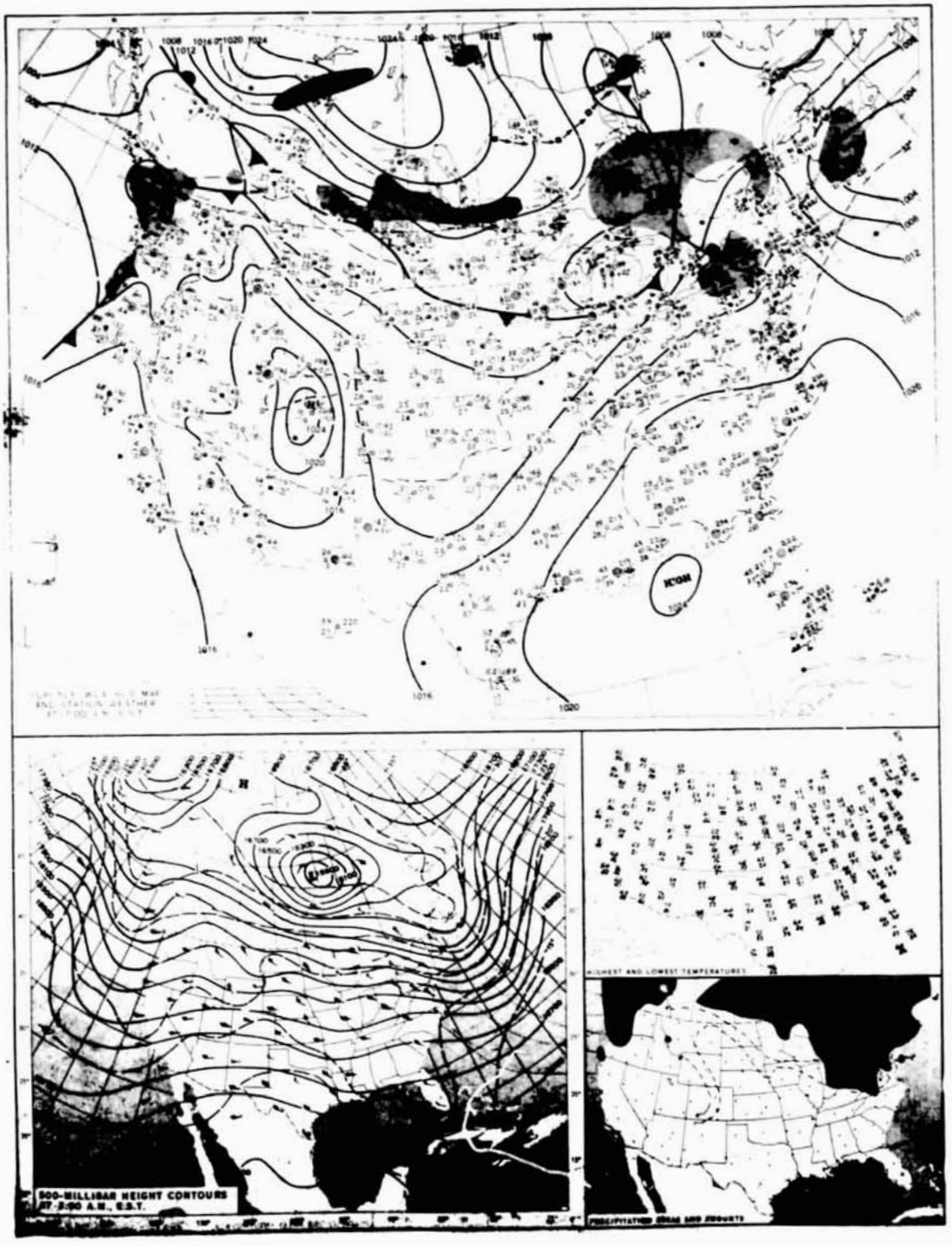
SYNOPTIC CHARTS

PRECEDING PAGE BLANK NOT FILMED

SUNDAY, FEBRUARY 10, 1974






500-MILLIBAR HEIGHT CONTOURS
AT 7:00 A.M., E.S.T.
HIGHEST AND LOWEST TEMPERATURES
PRECIPITATION AREAS AND AMOUNTS

APPENDIX B

SURFACE OBSERVATIONS

FEDERAL METEOROLOGICAL FORM 1-10 SURFACE WEATHER OBSERVATIONS (ABRIDGED FO. FOR USE AT AWS STATIONS)

Latitude: 28° 29' N | Longitude: 80° 33' W | Station elevation: 20 feet (MSL) | Day: 11 | Month: FEB | Year: 1974 | Station and state: CAPE KENNEDY AFS, FLA

Type (1)	Time (LST) (2)	Sky condition (3)	Visibility (miles) (4)	Weather and obstructions to vision (5)	Sea level press. (mb) (6)	Temp (°F) (7)	Dew point (°F) (8)	Wind true direction (9)	Wind speed (knots) (10)	Wind character (11)	Altimeter (inches) (12)	Remarks and supplementary coded data (13)	Station pressure (inches)	Total sky cover	Obs. initials
R	0058	250	10		230	45	36	28	03		021	CCC 1501	30.190	1	RT
R	0157	110 ①	10		229	42	36	26	03		020	RADAT 13100	30.180	3	RT
R	0258	110 ①	10		220	43	37	24	03		018		30.160	4	RT
R	0358	120 ① E250 ①	10		226	37	33	23	02		018	610 1032	30.160	6	RT
R	0458	120 ① 250 ①	10		217	35	32	22	01		017		30.150	4	RT
R	0555	E110 ① 240 ①	10		224	33	31	24	03		019		30.170	7	WT
R	0655	40 ① 240 ①	10		227	33	32	28	02		020	307 1502	30.180	4	WT
L	0740											1522 WN3/34.4/319/ *			WT
L	0745	40 ① 240 ①	10					27	02						WT
R	0758	40 ① 240 ①	10		230	40	35	28	03		021		30.190	1	WT
L	0815	40 ①	10					29	03						WT
L	0830	40 ①	10					28	04						WT
L	0845	40 ①	10					29	06						WT
R	0849	○	10		234	53	42	29	07		022	SC SW *	30.200	0	WT
L	0850											1522 7/32.5/470 *			WT
R	0858	○	10		234	53	42	30	05		022	SC SW	30.200	0	WT
R	0956	220 ①	10		234	54	40	31	08		022	107 1002 RADAT 11086	30.200	1	[illegible]
R	1055	○	10		237	60	33	30	10		023		30.205	0	[illegible]
R	1156	○	10		230	59	32	32	07	617	021		30.190	0	[illegible]
R	1256	○	10		220	62	33	30	07		018	814	30.160	0	[illegible]
R	1356	○	10		207	62	33	30	06		014		30.120	0	[illegible]
R	1458	○	10		200	65	32	31	07		012		30.100	0	[illegible]
R	1556	○	10		196	64	39	01	04		011	624	30.090	0	[illegible]
R	1655	○	10		200	62	39	03	02		012		30.100	0	[illegible]
R	1758	○	10		207	59	45	03	02		014		30.120	0	NE
R	1856	○	10		210	50	40	04	02		015	112	30.125	0	NE
R	1957	○	10		213	43	38	00	00		016		30.135	0	NE
R	2057	○	10		217	40	36	34	02		017		30.150	0	NE
R	2156	○	10		224	39	34	31	02		019	114	30.165	0	NE
R	2258	○	10		227	46	44	27	04		020		30.180	0	NE
R	2356	○	10		227	49	45	28	04		020		30.180	0	NE

Summary of the day

Precip.	Snowfall	Snow depth
0	0	0

Peak wind

Speed	Direction	Time
17	32	1154

APPENDIX C

RAWINSONDE DATA

RAWINSONDE RUN AN/GMD-4
CAPE KENNEDY AFS, FLORIDA
0515Z 10 FEB 1974
ASCENT NBR 0083

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	310	11	8.0	1.7	1021.00	64	5.34	1261.72	314	653	0	0
1000	306	21	5.3	-0.5	984.46	66	4.58	1228.69	303	658	.017	302
2000	300	21	2.6	-3.5	948.29	68	3.96	1195.51	291	647	.004	227
3000	297	21	2.7	-23.2	913.28	13	.75	1152.93	262	647	.002	177
4000	295	19	1.9	-28.8	879.49	8	.45	1113.73	251	646	.002	168
5000	290	19	.1	-29.9	846.79	8	.40	1079.18	243	644	.003	174
6000	284	20	-0.9	-30.5	815.16	8	.38	1042.74	235	643	.004	231
7000	279	25	-2.6	-32.0	784.56	8	.33	1010.62	227	641	.009	261
8000	272	31	-4.1	-33.4	754.95	8	.29	977.22	220	639	.012	248
9000	261	38	-4.3	-33.6	726.36	8	.29	941.20	212	639	.017	223
10000	248	48	-3.9	-30.3	698.87	11	.41	904.05	204	639	.022	209
11000	240	57	-4.0	-30.8	672.44	11	.42	870.00	197	639	.021	205
12000	235	67	-4.8	-33.7	647.01	8	.28	837.25	188	639	.019	207
13000	233	74	-3.7	-26.7	622.56	18	.67	804.56	184	639	.013	214
14000	232	84	-4.8	-12.3	599.02	56	1.92	776.51	180	638	.015	229
15000	236	89	-6.4	-32.0	576.25	11	.35	752.26	170	636	.013	276
16000	237	91	-8.3	-23.9	554.19	38	.94	728.32	169	634	.004	283
17000	237	92	-10.5	-12.5	532.87	85	1.94	705.50	170	631	.002	254
18000	238	96	-12.2	-13.9	512.19	88	1.74	682.85	164	629	.007	261
19000	241	98	-13.2	-20.1	492.21	57	1.06	658.93	154	628	.009	305
20000	241	98	-14.9	-29.7	472.92	27	.44	637.60	145	626	.000	228

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
576	307	17	6.5	.4	1000	65
1949	301	21	2.6	-2.5	950	71
3383	297	20	2.5	-25.8	900	10
4892	291	19	.2	-29.8	850	8
6481	282	22	-1.6	-31.0	800	8
8156	271	32	-4.2	-33.5	750	8
9939	249	47	-3.9	-30.6	700	11
11857	235	66	-4.0	-33.6	650	8
13929	232	83	-4.8	-12.2	600	56
16158	237	91	-8.7	-21.2	550	48
18563	240	98	-12.7	-16.3	500	76

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	310	11	8.0	1.7	1021.00	314
1903	301	21	2.6	-1.5	951.74	295
2887	297	21	2.8	-22.5	917.17	263
7621	277	29	-3.8	-33.2	766.07	223
12501	233	72	-3.8	-34.0	634.64	185
13515	232	77	-3.7	-19.2	610.35	183
13718	231	81	-4.5	-12.0	605.59	187
14382	233	87	-5.2	-12.6	590.26	183
14594	235	88	-5.7	-34.4	585.43	172
15646	237	91	-7.3	-28.8	564.14	168
16953	237	92	-10.3	-12.3	533.86	170
17648	237	94	-11.9	-15.2	519.40	164
19043	238	96	-12.3	-13.7	511.31	164
19372	240	97	-12.5	-14.0	504.68	162

RAWINSONDE RUN AN/GMD-4
CAPE KENNEDY AFS, FLORIDA
1115Z 10 FEB 1974
ASCENT NBR 0004

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	310	10	5.3	-2.3	1023.00	58	4.00	1277.60	310	650	0	0
1000	341	23	5.1	-2.6	986.20	58	3.93	1232.53	299	650	.028	8
2000	342	25	3.5	99.9	950.01	999	99.99	1194.81	281	648	.004	356
3000	337	27	2.9	-16.4	914.98	23	1.33	1154.11	266	647	.004	277
4000	332	26	.1	-17.3	881.04	26	1.24	1122.56	258	644	.004	238
5000	323	25	-1.9	-17.5	848.07	29	1.24	1088.43	250	642	.007	221
6000	314	28	-3.7	-16.5	816.13	37	1.37	1054.18	244	640	.008	262
7000	312	34	-5.6	-17.4	785.19	39	1.27	1021.51	238	637	.018	303
8000	310	40	-7.4	-23.1	755.23	27	.78	989.42	226	635	.010	296
9000	309	44	-8.4	99.9	726.23	999	99.99	955.32	215	634	.007	299
10000	307	46	-8.8	-36.7	698.31	8	.22	920.21	206	633	.004	282
11000	302	48	-8.2	-40.4	671.43	5	.14	882.71	198	634	.008	244
12000	296	49	-8.9	-40.8	645.62	5	.14	851.03	190	633	.009	228
13000	284	50	-9.2	99.9	620.73	999	99.99	819.39	183	633	.017	203
14000	272	53	-8.4	-40.5	596.83	5	.14	785.29	176	634	.019	204
15000	255	68	-10.1	99.9	573.82	999	99.99	759.84	169	632	.048	214
16000	255	73	-9.9	99.9	551.65	999	99.99	729.97	163	632	.008	252
17000	256	78	-11.0	99.9	530.31	999	99.99	704.67	157	631	.009	274
18000	257	83	-12.8	-42.8	509.67	6	.11	681.88	153	629	.008	268
19000	258	85	-14.4	-44.5	489.69	6	.09	659.34	148	627	.005	288
20000	260	86	-17.3	-45.1	470.34	7	.09	640.37	143	623	.005	335

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
626	336	22	5.5	-3.9	1000	51
1997	342	25	3.5	99.9	950	999
3432	335	27	1.7	-17.4	900	23
4932	324	25	-1.8	-17.4	850	29
6506	313	31	-4.7	-15.2	800	44
8163	309	40	-7.5	-24.2	750	25
9920	308	45	-8.8	-36.2	700	9
11804	297	49	-8.7	-40.7	650	5
13836	274	52	-8.5	99.9	600	999
16041	255	73	-9.9	99.9	550	999
18437	257	84	-13.8	-44.6	500	5

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	310	10	5.3	-2.3	1023.00	310
437	333	22	5.7	-4.3	1007.08	301
1768	343	25	3.8	-1.2	958.32	296
2277	341	26	3.2	99.9	940.18	264
2794	338	26	3.2	-15.6	922.09	268
3239	336	27	2.4	-17.5	906.79	263
3709	334	27	.8	-17.3	890.81	260
6227	313	29	-4.8	-14.6	809.04	243
8804	309	43	-8.8	-24.3	731.84	219
9258	309	44	-7.8	99.9	718.93	210
9800	308	45	-8.7	-35.0	703.82	208
11213	301	49	-7.9	-40.3	665.86	196
12173	294	49	-9.0	-40.8	641.25	189
12709	288	49	-9.3	99.9	627.88	185
13284	280	50	-9.2	99.9	613.84	180
13879	274	52	-8.4	-40.5	599.67	177
14406	266	56	-8.3	-40.5	587.40	173
14600	259	61	-10.1	99.9	582.93	172
16544	256	76	-9.9	99.9	539.94	159
17012	256	78	-11.0	99.9	530.06	157
17522	256	81	-11.8	-43.7	519.44	155
18864	257	85	-14.0	-44.7	492.37	148

RAWINSONDE RUN AN/GMD-4
CAPE KENNEDY AFS, FLORIDA
1430Z 10 FEB 1974
ASCENT NBR 0089

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	320	8	9.7	-0.0	1025.10	51	4.67	1259.84	310	655	0	0
1000	339	15	7.4	.9	988.62	64	5.02	1224.70	304	652	.013	0
2000	340	16	5.3	-2.8	952.62	56	3.89	1189.48	289	650	.003	346
3000	334	17	3.0	-14.5	917.64	28	1.72	1156.55	269	647	.003	270
4000	325	20	.8	-17.5	883.65	24	1.22	1122.82	258	645	.006	280
5000	319	25	-0.7	-13.7	850.72	37	1.70	1086.58	253	643	.009	299
6000	319	29	-2.5	-18.0	818.83	29	1.21	1053.16	242	641	.007	317
7000	321	31	-3.0	-29.8	787.99	11	.45	1018.00	229	640	.004	350
8000	327	33	-2.8	99.9	758.30	999	99.99	976.98	219	641	.007	21
9000	330	34	-3.8	-34.9	729.68	7	.25	943.59	212	639	.004	19
10000	336	37	-3.8	99.9	702.08	999	99.99	907.97	202	639	.007	26
11000	338	37	-3.2	99.9	675.58	999	99.99	871.94	194	640	.003	59
12000	338	36	-3.7	99.9	650.07	999	99.99	840.63	187	639	.002	161
13000	334	36	-4.4	99.9	625.47	999	99.99	810.85	181	639	.004	237
14000	326	37	-5.7	99.9	601.72	999	99.99	783.93	175	637	.009	258
15000	315	40	-7.7	99.9	578.74	999	99.99	759.42	169	635	.013	252
16000	305	41	-9.4	99.9	556.48	999	99.99	735.04	164	633	.013	231
17000	296	43	-11.5	99.9	534.93	999	99.99	712.21	159	630	.011	222
18000	293	44	-13.4	99.9	514.07	999	99.99	689.52	154	628	.005	225
19000	290	44	-15.5	-45.4	493.85	6	.09	667.68	149	625	.004	216
20000	286	46	-18.4	-46.9	474.26	6	.07	648.55	145	622	.006	227

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
688	336	12	8.1	.6	1000	59
2071	340	16	5.2	-3.2	950	55
3510	329	18	1.9	-17.2	900	23
5014	319	25	-0.7	-13.6	850	37
6595	320	30	-2.9	-24.7	800	19
8272	328	34	-3.0	-32.7	750	8
10058	336	37	-3.6	99.9	700	999
11979	338	36	-3.7	99.9	650	999
14044	325	37	-5.9	99.9	600	999
16262	302	42	-9.9	99.9	550	999
18649	291	44	-14.8	-45.1	500	5

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	320	8	9.7	-0.0	1025.10	310
1178	341	16	7.0	1.0	982.14	303
2150	340	16	5.0	-3.5	947.33	287
3197	332	17	2.6	-17.0	910.89	264
5174	318	26	-0.9	-12.8	845.10	252
6172	319	30	-2.8	-19.1	813.47	240
7133	321	31	-3.1	-31.5	783.98	227
7684	325	32	-2.5	99.9	767.55	220
8206	328	33	-2.9	-32.4	752.33	218
9148	330	34	-3.9	-35.4	725.53	211
9799	334	37	-4.2	99.9	707.54	204
11316	339	37	-3.2	99.9	667.41	192
13453	332	36	-4.7	99.9	614.63	178
17266	295	43	-12.1	99.9	529.33	157
18252	292	44	-13.9	-44.7	508.92	153
19378	289	44	-16.3	-45.8	486.41	148
20365	284	47	-19.6	-47.6	467.29	144
24020	287	60	-27.3	-52.0	401.49	127
25045	999	999	-29.2	-52.3	384.44	123

RAWINSONDE RUN AN/GMD-4
CAPE KENNEDY AFS, FLORIDA
0300Z 11 FEB 1974
ASCENT NBR 0086

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/M N	VS KTS	SHEAR /SEC	SHEAR DEG
16	200	4	-0.8	-2.3	1022.40	90	4.11	1305.43	317	643	0	0
1000	260	12	10.0	-7.9	986.11	27	2.59	1211.62	286	656	.018	279
2000	261	14	7.4	-8.8	950.47	31	2.43	1178.77	278	653	.003	272
3000	264	15	4.3	-9.0	915.76	37	2.42	1148.23	271	649	.003	284
4000	294	17	4.9	-16.2	882.11	23	1.45	1104.45	255	650	.014	359
5000	296	19	7.3	-20.9	849.97	11	.80	1055.32	241	652	.004	314
6000	289	20	6.1	-21.3	819.03	12	.	1021.08	233	651	.004	232
7000	284	21	4.9	-22.0	789.08	12	.82	988.30	225	650	.003	223
8000	283	23	3.5	-20.2	760.09	16	.96	956.58	219	648	.003	263
9000	284	25	2.4	-18.7	732.06	19	1.10	924.83	213	647	.004	300
10000	286	27	.1	-20.4	704.98	20	.96	898.10	206	644	.004	300
11000	288	29	-1.8	-23.5	678.55	17	.74	870.59	199	642	.003	319
12000	290	30	-3.2	-25.7	653.03	16	.60	842.43	192	640	.002	333
13000	287	29	-4.7	-27.5	628.34	15	.51	815.09	185	638	.002	163
14000	285	30	-5.7	-28.6	604.47	14	.46	787.06	178	637	.003	230
15000	282	33	-7.2	-30.3	581.42	14	.40	761.40	172	635	.005	253
16000	279	34	-10.1	-32.3	559.06	14	.33	740.18	167	632	.003	218
17000	277	33	-12.6	-33.9	537.35	15	.28	718.27	162	629	.003	150
18000	271	33	-15.4	-36.0	516.27	15	.23	697.67	157	625	.005	143
19000	267	35	-18.1	-37.9	495.80	16	.19	677.19	152	622	.006	218
20000	265	40	-20.6	-40.0	475.95	16	.16	656.47	147	619	.008	255

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
617	259	11	10.8	-6.1	1000	30
2010	261	14	7.4	-8.8	950	31
3458	265	16	3.3	-8.6	900	41
4991	296	19	7.3	-20.9	850	11
6620	286	21	5.4	-21.9	800	12
8341	283	23	3.3	-19.3	750	17
10164	286	28	-0.3	-20.7	700	20
12097	289	30	-3.4	-25.9	650	15
14162	284	31	-5.9	-29.0	600	14
16378	278	33	-11.2	-33.1	550	14
18749	267	35	-17.6	-37.6	500	15

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	200	4	-0.8	-2.3	1022.40	317
237	258	9	11.4	-2.4	1014.03	300
1699	260	13	8.5	-8.5	961.12	280
2583	263	15	5.3	-9.3	930.15	274
3596	265	16	3.0	-8.5	895.57	267
3675	286	16	2.2	-9.2	892.89	267
4149	297	17	6.1	-19.4	877.20	250
5191	296	19	7.4	-21.0	843.99	239
14623	283	32	-6.3	-29.8	590.04	174
16560	269	34	-17.0	-37.2	504.74	154

TEST NBR 05775
RAWINSONDE RUN AN/GMD-4
CAPE KENNEDY AFS, FLORIDA
0400Z 11 FEB 1974
ASCENT NBR 0067

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	260	6	7.8	1.5	1022.50	64	5.23	1244.81	314	653	0	0
1000	270	18	9.1	-0.7	966.15	58	4.46	1214.57	298	654	.021	284
2000	269	17	7.3	-7.7	950.47	33	2.64	1179.12	279	652	.004	166
3000	267	18	5.0	-11.7	915.79	29	1.94	1146.04	258	650	.001	233
4000	277	17	4.3	-13.1	882.41	27	1.75	1106.69	258	649	.005	16
5000	295	17	7.6	-28.8	849.92	5	.44	1054.24	238	653	.009	16
6000	295	16	6.4	-28.5	818.99	6	.45	1020.20	230	651	.002	296
7000	288	22	5.4	-28.5	789.09	6	.45	986.81	223	650	.007	258
8000	284	25	3.6	-25.5	760.12	10	.61	956.31	217	648	.006	259
9000	282	27	2.0	-23.1	732.07	13	.79	926.50	211	646	.003	254
10000	281	28	.1	-23.8	704.88	14	.71	898.25	205	644	.002	250
11000	281	29	-2.2	-25.8	678.58	14	.60	872.18	198	641	.002	287
12000	283	30	-4.1	-29.0	652.92	12	.45	845.04	191	639	.003	307
13000	283	32	-5.3	-31.6	628.16	11	.35	816.85	184	638	.002	290
14000	281	32	-6.9	-33.8	604.22	10	.28	790.55	176	636	.002	192
15000	277	32	-7.9	-35.9	581.09	8	.23	763.11	172	634	.004	194
16000	272	34	-9.5	-37.4	558.73	8	.20	738.15	166	633	.006	221
17000	268	36	-12.2	-38.7	537.07	9	.18	716.92	161	629	.006	223
18000	265	38	-14.7	-40.7	516.04	9	.14	695.45	156	626	.004	226
19000	264	40	-17.4	-42.2	495.64	9	.12	675.09	151	623	.004	239
20000	261	45	-19.7	-44.2	475.86	9	.10	654.15	146	620	.008	238

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
920	281	19	8.5	-0.7	1000	51
2010	269	17	7.3	-7.8	950	33
3460	271	18	4.7	-12.7	900	27
4989	295	17	7.4	-28.8	850	5
6520	290	21	5.9	-28.8	800	6
8042	284	26	3.1	-23.6	750	12
10164	281	28	-.3	-23.8	700	15
12092	283	30	-4.2	-29.4	650	12
14150	280	31	-7.3	-34.3	600	9
16364	270	35	-11.4	-37.9	550	8
18740	264	40	-16.5	-41.9	500	9

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	260	6	7.8	1.5	1022.50	314
236	285	19	8.5	-0.7	1014.18	307
1146	279	18	9.2	-0.7	980.87	297
2682	267	18	5.0	-11.5	919.84	269
4472	288	17	3.3	-9.4	860.73	258
4786	294	17	7.9	-28.9	850.00	234
9471	282	27	1.1	-24.0	719.10	208
11432	282	29	-3.4	-27.3	667.38	145
15286	279	32	-8.0	-36.4	574.62	170
19118	263	41	-17.7	-42.3	493.28	151

RAWINSONDE RUN AN/GMD-1
CAPE KENNEDY AFS, FLORIDA
1000Z 11 FEB 1974
ASCENT NBR 0088

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	I/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	220	1	1.8	.0	1021.00	88	4.82	1290.51	318	646	0	0
1000	291	21	8.4	3.1	984.50	69	5.86	1214.58	307	654	.034	294
2000	298	25	6.5	3.2	948.81	79	5.94	1178.40	300	651	.009	323
3000	300	29	4.4	1.6	914.18	83	5.38	1144.37	289	649	.007	316
4000	302	28	2.3	.9	880.57	90	5.13	1110.47	280	647	.002	66
5000	300	27	5.2	-9.9	848.18	33	2.26	1060.10	250	650	.003	157
6000	296	25	3.7	-10.8	817.07	34	2.11	1026.88	242	648	.04	171
7000	296	25	2.2	-10.6	786.94	38	2.15	994.47	235	646	.000	115
8000	296	27	.3	-10.2	757.75	45	2.23	964.11	229	644	.004	295
9000	291	30	-1.3	-11.6	729.47	45	2.01	933.64	221	642	.006	251
10000	285	32	-3.2	-13.6	702.08	44	1.71	904.93	213	640	.006	229
11000	282	34	-5.2	-16.2	675.53	42	1.39	877.61	205	638	.004	236
12000	282	35	-6.1	-18.9	649.84	35	1.11	847.15	196	637	.002	268
13000	280	37	-7.7	-20.8	625.01	34	.95	819.65	189	635	.003	253
14000	277	39	-8.6	-22.0	601.02	33	.86	791.83	182	634	.006	240
15000	274	43	-10.0	-23.3	577.85	33	.77	764.43	175	632	.007	241
16000	271	47	-12.0	-25.0	555.44	33	.66	740.45	169	630	.007	248
17000	270	51	-14.1	-26.8	532.74	33	.57	717.44	164	627	.007	253
18000	269	54	-16.0	-27.9	512.72	35	.51	694.37	158	625	.005	250
19000	268	56	-18.6	-29.1	492.36	39	.46	673.62	153	622	.004	255
20000	268	58	-21.3	-31.8	472.61	38	.36	653.47	148	618	.004	258

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	RH PCT
574	272	15	9.2	3.3	1000	67
1963	298	25	6.6	3.2	950	79
3413	301	29	3.4	1.2	900	85
4935	301	27	5.0	-9.1	850	37
6551	296	25	2.9	-11.0	800	35
8256	296	28	-0.3	-10.4	750	46
10058	285	32	-3.3	-13.8	700	44
11970	282	35	-6.1	-18.9	650	35
14014	277	39	-8.7	-22.0	600	33
16213	271	48	-12.5	-25.4	550	33
18578	268	55	-17.6	-28.6	500	37
21132	267	61	-24.1	-30.3	450	57

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS MBS	I/R N
16	220	1	1.8	.0	1021.00	318
548	269	15	9.2	3.3	1001.00	311
4169	303	28	2.0	.8	875.00	279
5006	300	27	5.3	-9.9	848.00	250
11097	282	34	-5.4	-16.5	673.00	204
14515	275	41	-9.2	-22.5	589.00	178
15392	272	44	-10.6	-23.9	569.00	173
18181	268	54	-16.4	-28.1	509.00	157
21024	267	60	-24.1	-31.0	453.00	144
21998	266	62	-24.1	-26.3	435.00	140
23760	999	999	-28.2	-29.8	404.00	131

TEST NBR 05775 04016
RAWINSONDE RUN AN/GMD-1
CAPE KENNEDY AFS, FLORIDA
13104 11 FEB 1974
SCENT NBR 0089

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	Dew PT DEG C	PRESS MBS	RH PCT	AB HUM G/M3	DENSITY G/M3	T/R N	VS KTS	SHEAR /SEC	SHEAR DEG
16	280	3	6.[illegible]	5,5	1022,40	79	6,96	1258,24	323	654	0	0
1000	313	19	7,6	,8	986,04	62	5,00	1220,54	303	653	,029	319
2000	311	25	5,6	1,8	950,17	77	5,42	1184,22	298	650	,009	304
3000	304	25	3,2	-1,0	915,38	74	4,46	1149,28	285	648	,005	[illegible]
4000	309	20	3,0	-10,4	881,03	37	2,21	1110,73	261	647	,009	[illegible]
5000	310	20	3,8	-11,7	849,16	31	1,96	1046,94	250	648	0	
6000	304	21	3,3	-10,5	817,91	35	2,15	1029,43	243	648	,005	[illegible]
7000	303	27	3,0	-12,9	787,78	30	1,78	992,64	232	647	,009	[illegible]
8000	302	34	1,4	99,9	758,67	999	99,99	961,87	222	646	,011	[illegible]
9000	296	36	-0,8	-15,7	730,41	31	1,44	933,31	217	643	,007	241
10000	291	35	-2,4	-19,1	703,05	26	1,08	904,03	208	641	,006	194
11000	291	39	-4,6	-21,4	676,52	26	,89	877,21	201	638	,006	294
12000	297	42	-7,1	-23,6	650,77	25	,74	851,60	195	635	,009	342
13000	298	43	-8,4	-25,4	625,83	24	,63	823,08	188	634	,002	347
14000	295	45	-9,3	-26,4	601,71	23	,58	794,15	181	633	,005	236
15000	292	47	-11,6	-27,7	578,46	24	,52	768,31	175	631	,006	252
16000	289	49	-13,8	-29,5	555,98	25	,44	746,41	169	627	,005	229
17000	284	50	-16,0	-31,6	534,08	25	,36	723,24	164	625	,007	209
18000	278	50	-18,8	-33,4	512,78	26	,31	702,09	159	621	,008	192
19000	277	54	-20,5	-33,3	492,23	31	,31	678,64	153	619	,007	264
20000	278	55	-22,9	-33,4	472,54	37	,31	657,29	149	616	,002	296

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	Dew PT DEG C	PRESS MBS	RH PCT
918	311	17	8,6	1,2	1000	59
2002	311	25	5,6	1,8	950	77
3446	305	23	2,[illegible]	-3,3	900	64
4965	310	20	3,8	-11,7	850	31
6579	305	24	3,2	-11,8	800	32
8289	301	35	,5	99,9	750	999
10094	291	35	-2,7	-19,6	700	26
12002	292	42	-7,1	-23,7	650	25
14043	294	45	-9,3	-26,4	600	23
16431	287	49	-14,6	-30,2	550	25
18975	277	52	-19,7	-32,9	500	29

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	Dew PT DEG C	PRESS MBS	T/R N
16	280	3	6,[illegible]	5,5	1022,40	323
494	309	14	8,6	1,5	1014,00	311
2721	305	26	4,2	,7	925,00	290
3070	304	25	3,0	-1,4	913,00	283
4110	310	19	3,8	-11,9	876,00	256
7462	304	28	3,[illegible]	-13,4	785,00	231
7684	305	33	1,8	-13,6	782,00	226
8269	301	35	,6	99,9	751,00	214
8857	299	36	-0,2	-14,9	740,00	240
12388	298	43	-7,8	-24,8	641,00	192
13903	295	44	-8,3	-26,4	604,00	181
14243	294	45	-8,4	-26,4	596,00	179
15816	289	48	-13,1	-29,0	560,00	170
16276	288	49	-14,4	-30,0	552,00	166
17468	281	49	-17,0	-32,5	529,00	161
17894	279	49	-18,5	-33,7	519,00	159

APPENDIX D

WINDSONDE DATA

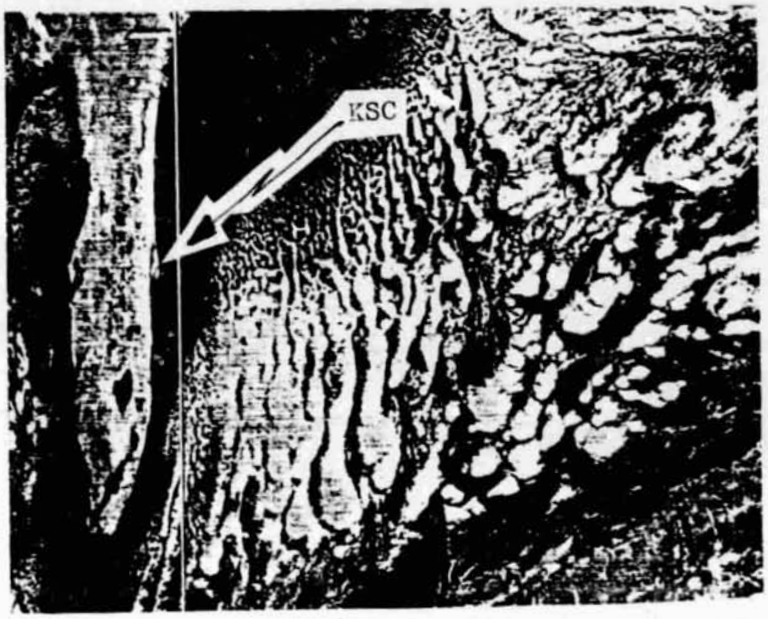
WINDSONDE
CAPE KENNEDY AFS , FLA.
0903Z 11 FEB 1974
ASCENT NBR. 0030

ALT FT.	WDIR	WKTS	SHEAR	
000016	220	002	0000	000
001000	263	018	.023	268
002000	296	024	.022	345
003000	300	031	.013	311
004000	305	029	.006	073
005000	303	026	.006	103
006000	290	024	.013	195
007000	297	026	.005	350
008000	293	031	.009	302
009000	292	030	.006	181
010000	289	034	.008	269
011000	282	032	.008	163
012000	281	030	.004	112
013000	277	030	.004	198
014000	276	035	.009	273
015000	270	040	.011	236
016000	269	042	.003	244
017000	263	037	.008	095
018000	268	042	.007	262
019000	263	045	.009	216
020000	261	052	.011	248

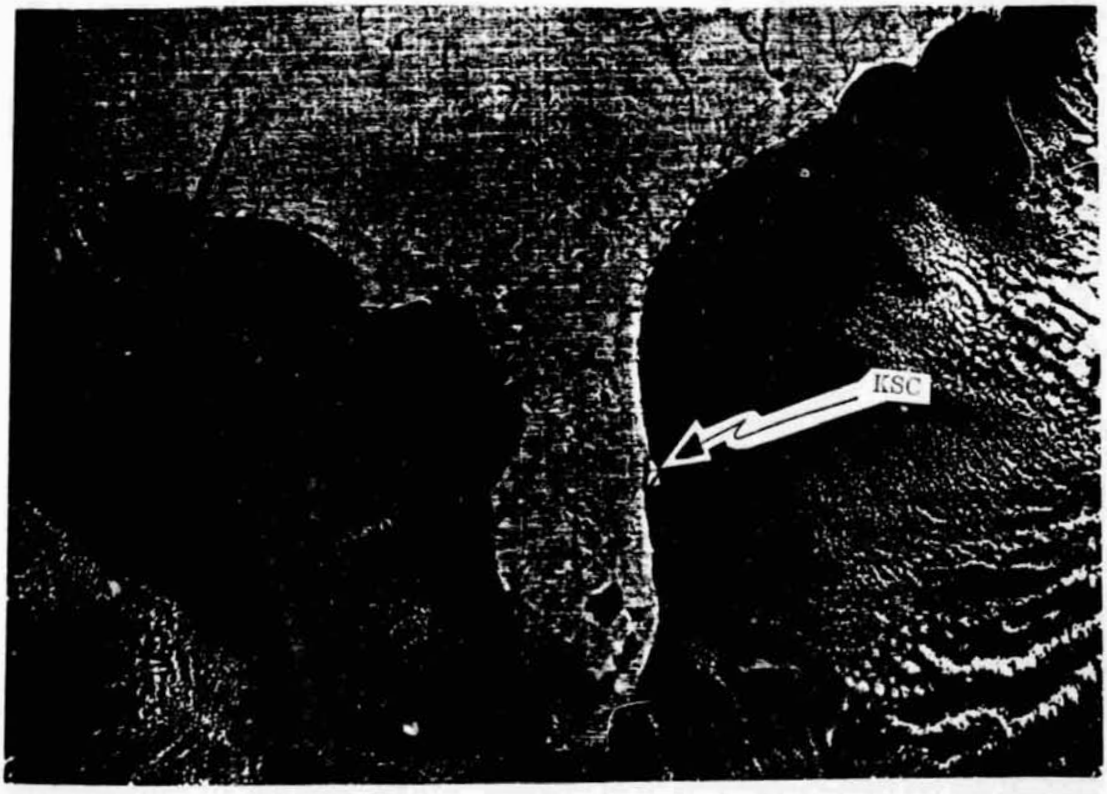
APPENDIX E

SATELLITE IMAGERY

SATELLITE IMAGERY (IR)



NOAA 2 ORBIT 6052 10 FEBRUARY 1974, 2058 EDT



NOAA 2 ORBIT 6065 11 FEBRUARY 1974, 2205 EDT

APPENDIX F

CALCULATION OF THERMODYNAMIC VARIABLES FROM RAWINSONDE DATA

The equations used for calculation of thermodynamic variables from measurements of altitude, temperature and relative humidity obtained from the GMD-4, AMQ-9 rawinsonde system are summarized herein; these equations, originally developed for the GMD-2 system (Ref. 1), must be used in conjunction with the list of symbols and units provided at the end of this appendix.

Atmospheric Density, ρ

$$\rho = 348.38 \frac{P}{T_v}$$

Pressure, P

$$P = P' 10^{-(h-h')/(221.266\ T_{vm})}$$

Geopotential Height, h

$$h = \frac{g_o}{9.8} \frac{r_e H}{r_e + H}$$

Virtual Temperature, T_v

$$T_v = T(1 + .376932\ e/P')$$

Mean Virtual Temperature, T_{vm}

$$T_{vm} = \frac{T'_v + T_v}{2}$$

Vapor Pressure, e

$$e = 6.11\ f_D\ 10^{7.5t/(t+237.3)}$$

Dew Point Temperature, t_d

$$t_d = \frac{237.3 \log e - 186.527}{8.236 - \log e}$$

Potential Temperature, θ

$$\theta = T \left(\frac{1000}{P}\right)^{.288}$$

Virtual Potential Temperature θ_v

$$\theta_v = T_v \left(\frac{1000}{P}\right)^{.288}$$

Absolute Humidity, ρ_w

$$\rho_w = 216.7\ e/p$$

Microwave Refractive Index, n

$$n = 1 + \left[\frac{1}{T}\left(77.6P - 11e + \frac{374808e}{T}\right)\right] 10^{-6}$$

For data tabulation, use:

$$N = (n-1)10^6$$

Speed of Sound, V_s

$$V_s = 643.855 \left(\frac{T}{273.16}\right)^{0.5}$$

LIST OF SYMBOLS AND UNITS

e	vapor pressure	millibars (mb)
f_D	relative humidity expressed as a decimal	
g_o	acceleration of gravity at geographical location of the rawinsonde station	meters/seconds^2 (m/sec^2)
h	geopotential height at the top of the layer bounded by h and h'	feet (ft)
h'	geopotential height at the bottom of the layer bounded by h and h'	(ft)
H	geometric altitude at the top of the layer bounded by H and H'	(ft)
H'	Geometric altitude at the bottom of the layer bounded by H and H'	(ft)
n	microwave refractive index	
N	unit of refractive index used for simplification of data tabulation	
P	pressure at geopotential height h	(mb)
p'	pressure at geopotential height h'	(mb)
r_e	radius of the earth	(ft)
t	temperature	degrees Celsius (^oC)
T	temperature	degrees Kelvin (^oK)
t_d	dew point temperature	(^oC)
T_v	virtual temperature at geopotential height h	(^oK)

T_v'	virtual temperature at geopotential height h'	(^oK)
T_{vm}	the mean virtual temperature of layer bounded by h and h'	(^oK)
V_s	speed of sound	knots
ρ	atmospheric density	grams/meter^3 (gm/m^3)
ρ_w	absolute humidity	(gm/m^3)
θ	potential temperature	(^oK)
θ_v	virtual potential temperature	(^oK)

REFERENCE

Daniel, O. H.: Digital Computer Reduction of AN GMD-2 Rawinsonde Data. Pan American World Airways, Guided Missile Range Division, Patrick Air Force Base, Florida, 10 May 1962.

APPROVAL

COMPENDIUM OF METEOROLOGICAL DATA FOR THE CENTAUR LAUNCH IN FEBRUARY 1974

By J. Briscoe Stephens, S. I. Adelfang, and A. I. Goldford

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

GEORGE F. FICHTL
Chief, Environmental Dynamics Branch

WILLIAM W. VAUGHAN
Chief, Aerospace Environment Division

CHARLES A. LUNDQUIST
Director, Space Sciences Laboratory

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